AF / 1765

PATENT APPLICATION

Applicants : Kazuo NAKAMURA et al

Title : BORON-DOPED ISOTOPIC DIAMOND AND PROCESS FOR PRODUCING THE SAME

Serial No. : 09/732 799 Group: 1765

Confirmation No.: 2965

Filed : December 8, 2000 Examiner: Kunemund

Atty. Docket No.: OPS Case 421A

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

FIRST CLASS MAILING CERTIFICATE

Sir:

I hereby certify that this correspondence is being deposited with the United States Postal Service under 37 CFR 1.8 as first class mail in an envelope addressed to: Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450, on August 26, 2003.

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Correspondence: Reply Brief Under 37 CFR 1.193(b)
dated August 26, 2003
including enclosures listed thereon

190.05/03

PATENT APPLICATION

IN THE U.S. PATENT AND TRADEMARK OFFICE

August 26, 2003

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REPLY BRIEF UNDER 37 CFR 1.193(b)

Sir:

This reply brief is filed pursuant to the provisions of 37 CFR 1.193(b) and is directed to points of argument made by the Examiner in the Examiner's Answer.

In the Examiner's Answer, it is stated that the sole difference between the instant claims and the prior art reference Tsuji et al is the doping of an isotopically pure diamond with boron. To provide this missing teaching, the Examiner cites Anthony et al '430 which is said to teach an isotopically pure diamond and the addition of boron to a diamond film. As such, the Examiner posits that it would have been obvious to modify the Tsuji et al process by the teachings of the Anthony et al reference to dope the diamond in order to enhance the properties in the diamond. However, the Tsuji et al method for synthesizing single diamond crystals of high thermoconductivity involves graphitizing amorphous carbon containing at least 99.9 atomic percent of carbon with a mass number of 12 at a minimum of 1800°C in an inert gas atmosphere to obtain a highly crystalline carbon and then subjecting the highly crystalline carbon to a high pressure and temperature in a temperature difference process to produce synthetic diamond crystals.

In contrast to Tsuji et al, the entire thrust of the Anthony et al reference is to improve the properties of diamonds prepared by chemical vapor deposition. This reference further discloses that boron can be added during the chemical vapor deposition process to reduce the intrinsic stress in a chemical vapor deposition diamond film or to improve the oxidation resistance of the film. Nothing in this reference suggests that any advantage would be gained by adding boron as an impurity to any other type of a diamond film than one that is formed by chemical vapor deposition.

To reconcile the differences in the processes between Anthony et al and Tsuji et al, the Examiner states that the affect (sic) of boron doping on a diamond is the same regardless of formation means. However, the Examiner has provided no other support for this opinion. Moreover, if the Examiner's opinion was actually the case, it would not be necessary for Anthony et al to limit their disclosure to stress relieving a diamond prepared by chemical vapor deposition since the disclosure would apply to a diamond prepared by any type of process. As such, Appellants respectfully submit that the combination of Tsuji et al with Anthony et al would not be obvious to one of ordinary skill in the art and only hindsight provided by the present disclosure is motivating the Examiner to make this combination.

While it is true that the Anthony et al reference does disclose an isotopically pure diamond film that can be a chemical vapor deposition diamond film and that boron can be present in the chemical vapor deposition diamond film in an amount of between 1-4,000 parts per million, there is no specific disclosure in this reference that a single crystal diamond P-type semiconductor can be formed having a thermoconductivity of from about 26 to 31 W/cm°K can be made from at least 99.5% isotopically pure ^{12}C or ^{13}C and boron in an amount not exceeding 100 parts per million. As stated previously, the amount of boron addition in the Anthony et al reference ranges between 1 to 4,000 parts per million. In the

present invention, the boron content is limited to not exceeding 100 parts per million in view of the thermoconductivity of the diamond. As shown in Example 4 on page 16 of the present specification, when 105 parts per million of boron is contained in an isotopically pure ^{12}C diamond, the full width at half maximum of a Ramant is unacceptably high and in fact compares with that of the undoped natural diamond as shown in Comparative Example 1 in Table 2 on page 15 of the present specification. As such, to get both high thermoconductivity and semiconducting properties, it is necessary that the boron content be limited to no more than 100 parts per million. This upper limit clearly is not suggested by Anthony et al, which is not surprising since Anthony et al is only concerned with the relief of stress or improvement in oxidation resistance of a CVD diamond film.

In response to Appellants' argument that adding impurities to an isotopically pure diamond film goes against the teachings of the art, the Examiner states that the cited prior art only relates to nitrogen as an impurity. However, the Anthony et al article submitted with the Response dated June 20, 2002, clearly states that the scattering of phonons can be induced by chemical impurities. Moreover, U.S. Patent No. 5 496 596, cited by the Examiner, states in Column 2, lines 31-34, that lattice inhomogeneities known to cause phonon scattering and reduced thermoconduction in diamonds include chemical impurities such as incorporated nitrogen, boron, or other non-carbon elements. Therefore, the Examiner clearly is in error in asserting that the present record only shows the desirability of removing nitrogen from the starting diamond source and that doping a diamond with an impurity such as boron would not be disadvantageous.

For the reasons cited above, it is respectfully submitted that the Examiner's rejection of the currently pending claims are in error and should be reversed. Favorable consideration is respectfully solicited.

Respectfully submitted,

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